Sleeping Sickness in Uganda.—Duration of the Infectivity of the Glossina palpalis *after the Removal of the Lake-shore Population.*

By Colonel Sir DAVID BRUCE, C.B., F.R.S., Army Medical Service; Captains A. E. HAMERTON, D.S.O., and H. R. BATEMAN, Royal Army Medical Corps; and Captain F. P. MACKIE, Indian Medical Service. (Sleeping Sickness Commission of the Royal Society, 1908—09.)

(Received November 16,—Read November 25, 1909.)

During the last two years the policy of clearing the shores and islands of Lake Victoria of their inhabitants has been carried out by the Uganda Administration, with a view to the stamping out of Sleeping Sickness.

It will be remembered that the area of distribution of Sleeping Sickness and of the *Glossina palpalis* in Uganda is the same, and is limited to a narrow belt along the Lake-shore and islands. For the past two years no native has been allowed to live or work within two miles of the Lake-shore, except at a few cleared landing-places; and within the last few months all the islands have been emptied.

Until recently it was believed that the fly only retained its infectivity for 48 hours, and that it would, theoretically, be possible with safety to clear an island of its infected population one day and restock it with healthy natives a few days later. Recent work, however, has shown this to be wrong, since it has been found by experiment that the fly can retain its infectivity up to 80 days. It is probable that after a fly has become infected it will harbour the trypanosomes for the rest of its life; but what the duration of this is, under natural conditions, is unknown.

From an administrative point of view, therefore, it is most important to find out how long the flies on the Lake-shore remain infective after the native population has been removed. Until this is known it will not be safe to allow the Lake-shore and islands to be re-inhabited.

As soon as the Sleeping Sickness Commission of the Royal Society reached Uganda experiments were begun to test this point. At first the flies were collected at Kibanga, a cleared landing-place in Buka Bay, six miles from the laboratory. This landing-place was used as a market, where the inhabitants of the Island of Buvuma came once a week to trade with the natives on the mainland. In November, 1908, Kibanga had become somewhat overgrown, and tsetse flies were present in some numbers. As the Buvuma

islanders were highly infected with Sleeping Sickness, this constituted a danger to the healthy natives of the mainland, who had come to the market from outside the Sleeping Sickness area. Steps were at once taken to have the landing thoroughly cleared of undergrowth, with the result that in a short time the flies disappeared.

The following experiment shows the result:—

Experiment 52.—Monkey.

To ascertain if *Glossina palpalis* caught at Kibanga market-place are capable of giving rise to Sleeping Sickness in a healthy monkey.

Date.	No. of flies.		Trypanosomes.	Malaria.	Date.	No. of flies.		Trypanosomes.	Malaria.
	Put on.	Fed.				Put on.	Fed.		
1908.					1908.				
Nov. 3	—	—	—	+	Dec. 6	—	—	—	+
„ 6	—	—	—	+	„ 7	—	—	—	+
„ 14	15	12	—	+	„ 15	—	—	—	+
„ 16	17	17	—	+	„ 17	1	1		
„ 17	7	7	—	+	„ 18	—	—	—	+
„ 18	4	1	—	+	„ 23	—	—	—	+
„ 19	7	4	—	+	„ 26	—	—	—	+
„ 20	—	—	—	+	„ 30	—	—	—	+
„ 22	50	34	—	+					
„ 23	—	—	—	+	1909.				
„ 24	—	—	—	+	Jan. 4	—	—	—	+
„ 25	—	—	—	+	„ 9	—	—	—	+
„ 27	—	—	—	+	„ 18	—	—	—	+
„ 29	—	—	—	+	„ 20	—	—	—	+
„ 30	—	—	—	+	„ 26	—	—	—	+
Dec. 2	10	7	—	+	„ 28	—	—	—	+
„ 3	12	5	—	+	Feb. 6	—	—	—	+
„ 4	5	3	—	+	Mar. 1	—	—	—	+

Remarks.—The result of this experiment is negative. The number of flies caught is small, and they soon disappeared as the clearing of the place proceeded.

The other experiments were all made with freshly-caught flies from uninhabited places on the Lake-shore. The Lake-shore, as stated above, had been cleared of its inhabitants in December, 1907, and had, therefore, been deserted for nearly a year when these experiments began. It was anticipated that the flies would be found non-infective, as, in the absence of Sleeping Sickness cases, it was difficult to understand where they could obtain the necessary trypanosomes, and at this time the long period of infectivity of the fly was unknown. The following experiments give the result:—

Experiment 214.—Monkey.

To ascertain if *Glossina palpalis*, caught on the Lake-shore, where there are no natives, are capable of giving rise to Sleeping Sickness in healthy monkeys.

Date.	No. of flies.		Trypanosomes.	Malaria.	Date.	No. of flies.		Trypanosomes.	Malaria.
	Put on.	Fed.				Put on.	Fed.		
1908.					1909.				
Nov. 23	21	10			Jan. 4	—	—	—	+
,, 24	25	20			,, 9	—	—	—	+
,, 25	50	26	—	+	,, 15	—	—	—	—
,, 26	30	17	—	+	,, 25	43	24		
,, 27	12	8			,, 26	35	29	—	+
,, 28	96	23	—	+	,, 28	—	—	—	+
,, 30	125	41	—	+	Feb. 2	100	65	—	+
Dec. 1	150	60	—	+	,, 3	105	105		
,, 2	—	—	—	+	,, 4	100	90		
,, 3	—	—	—	+	,, 5	—	—	—	+
,, 4	—	—	—	+	,, 6	100	85		
,, 5	60	23	—	+	,, 8	100	82		
,, 7	47	26	—	+	,, 9	200	165		
,, 12	60	49	—	+	,, 10	200	146	—	+
,, 14	83	37			,, 15	200	135	—	+
,, 15	78	32	—	+	,, 16	200	120		
,, 17	14	6			,, 17	170	126		
,, 18	—	—	—	+	,, 18	200	134		
,, 23	—	—	—	+	,, 19	200	110	—	+
,, 28	80	35	—	+	,, 20	200	124		
,, 30	70	32	—	+	,, 22	130	98		
					,, 23	200	140		
					,, 24	200	142		
					,, 25	200	135		
					,, 26	—	—	—	+
					Mar. 1	—	—	+	+

Remarks.—2500 flies were fed on this monkey for 98 days before a positive result was obtained.

Experiment 571.—Monkey.

Date.	No. of flies.		Trypanosomes.	Malaria.	Date.	No. of flies.		Trypanosomes.	Malaria.
	Put on.	Fed.				Put on.	Fed.		
1909.					1909.				
Mar. 2	200	152			Mar. 15	200	152		
,, 3	200	156			,, 16	100	78		
,, 4	100	78			,, 17	100	74		
,, 6	150	110			,, 18	100	58	—	+
,, 9	200	120	—	—	,, 20	200	112		
,, 10	200	110			,, 22	—	—	+	+
,, 11	200	124							

Remarks.—Result positive. Infection probably took place on March 15. This means that 1002 flies fed on this monkey before infection took place.

Experiment 612.—Monkey.

Date.	No. of flies.		Trypanosomes.	Malaria.	Date.	No. of flies.		Trypanosomes.	Malaria.
	Put on.	Fed.				Put on.	Fed.		
1909.					1909.				
Mar. 25	340	185			Mar. 29	100	76		
,, 26	250	124			,, 30	200	115	—	+
,, 27	200	115			April 6	—	—	+	+

Remarks.—Result positive. Infection probably March 30; 615 flies.

Experiment 674.—Monkey.

Date.	No. of flies.		Trypanosomes.	Malaria.	Date.	No. of flies.		Trypanosomes.	Malaria.
	Put on.	Fed.				Put on.	Fed.		
1909.					1909.				
April 8	250	160			April 23	270	180		
,, 9	500	240			,, 26	200	160	—	—
,, 10	500	220			,, 28	400	240		
,, 12	500	245	—	+	,, 30	400	160		
,, 15	500	340			May 1	500	290		
,, 19	—	—	—	—	,, 3	—	—	—	+
,, 20	250	180			,, 7	—	—	+ +	+
,, 22	300	190	—	—					

Remarks.—Result positive. Infection April 30; 2315 flies.

Experiment 758.—Monkey.

Date.	No. of flies.		Trypanosomes.	Malaria.	Date.	No. of flies.		Trypanosomes.	Malaria.
	Put on.	Fed.				Put on.	Fed.		
1909.					1909.				
May 8	270	210			May 22	—	—	—	+
,, 11	250	170			,, 28	200	130	—	+
,, 14	200	120			June 2	—	—	—	+
,, 17	—	—	—	+	,, 7	—	—	+	+

Remarks.—Result positive. Infection May 28; 630 flies.

Experiment 976.—Monkey.

Date.	No. of flies.		Trypano-somes.	Malaria.	Date.	No. of flies.		Trypano-somes.	Malaria.
	Put on.	Fed.				Put on.	Fed.		
1909.					1909.				
June 9	800	260			June 18	200	90	—	+
,, 10	450	180			,, 20	520	230		
,, 17	550	190			,, 21	—	—	+ +	+

Remarks.—Result positive. Infection June 10; 440 flies.

Experiment 1117.—Monkey.

Date.	No. of flies.		Trypano-somes.	Malaria.	Date.	No. of flies.		Trypano-somes.	Malaria.
	Put on.	Fed.				Put on.	Fed.		
1909.					1909.				
June 24	200	120			June 30	7	4		
,, 25	300	160			July 1	—	—	—	+
,, 26	150	80			,, 3	500	130		
,, 28	380	165			,, 5	500	220	+	+
,, 29	500	210							

Remarks.—Result positive. Infection June 28; 525 flies.

Experiment 1276.—Monkey.

Date.	No. of flies.		Trypano-somes.	Malaria.	Date.	No. of flies.		Trypano-somes.	Malaria.
	Put on.	Fed.				Put on.	Fed.		
1909.					1909.				
July 9	110	70			July 19	—	—	—	+
,, 12	500	230			,, 20	300	180		
,, 15	—	—	—	+	,, 22	—	—	+	+

Remarks.—Result positive. Infection July 12; 300 flies.

Experiment 1462.—Ox.

Date.	No. of flies.		Trypanosomes.	Malaria.	Date.	No. of flies.		Trypanosomes.	Malaria.
	Put on.	Fed.				Put on.	Fed.		
1909.					1909.				
Aug. 16	120	75	—		Aug. 20	170	80		
„ 17	410	250			„ 24	350	120	—	
„ 19	320	180	—		„ 26	—	—	+	

Remarks.—Result positive. Infection August 19 ; 505 flies.

Experiment 1465.—Ox.

Date.	No. of flies.		Trypanosomes.	Malaria.	Date.	No. of flies.		Trypanosomes.	Malaria.
	Put on.	Fed.				Put on.	Fed.		
1909.					1909.				
Aug. 27	150	90			Sep. 7	—	—	—	
„ 28	60	35			„ 9	30	19		
Sep. 4	230	170			„ 10	—	—	+ +	

Remarks.—Result positive. Infection September 4 ; 295 flies.

Experiment 982.—Ox.

Date.	No. of flies.		Trypanosomes.	Malaria.	Date.	No. of flies.		Trypanosomes.	Malaria.
	Put on.	Fed.				Put on.	Fed.		
1909.					1909.				
Sep. 11	45	36			Sep. 20	—	—	—	
„ 12	65	50			„ 21	115	85	—	
„ 14	110	75			„ 22	180	145		
„ 15	125	95			„ 23	410	380		
„ 16	420	160	—		„ 24	300	240	—	
„ 19	55	40			„ 27	370	230	+ +	

Remarks.—Result positive. Infection, September 19 ; 456 flies.

The following table summarises these results:—

Experiment.	Place.	No. of flies fed.	No. of days before infection took place.	Result.	Percentage of infected flies.*
52	Kibanga	91	—	—	—
214	Uninhabited Lake-shore	2500	98	+	0·04
571	,, ,,	1002	20	+	0·10
612	,, ,,	615	12	+	0·16
674	,, ,,	2315	29	+	0·04
758	,, ,,	630	30	+	0·16
976	,, ,,	440	12	+	0·23
1117	,, ,,	525	11	+	0·19
1276	,, ,,	300	13	+	0·33
1462	,, ,,	505	10	+	0·19
1465	,, ,,	295	14	+	0·34
982	,, ,,	456	16	+	0·22

* This is calculated on the assumption that there is only one infected fly in each batch of flies used in an experiment.

It must therefore be concluded that the Glossina palpalis *on the uninhabited shores of Victoria Nyanza can retain their infectivity for a period of at least two years after the native population has been removed.* How much longer they will remain infective it is impossible to say, but it is obvious that these experiments should be continued, in order to answer this important question.

With the facts at our disposal it is not possible to account for this continued infectivity. It may be due to the duration of the life of these flies being more than two years—that flies which became infected before the natives left are still alive. Or, it is possible that the flies have lately fed on natives suffering from Sleeping Sickness, who have been passing in canoes from the islands to the mainland, or on natives who still frequent the Lake-shore in spite of the prohibition. Thirdly, it might be explained, if any of our canoe-men or fly-boys had trypanosomes in their blood. Or, lastly, it is possible that the mammals and birds along the Lake-shore have become infected, and so act as a reservoir of the disease.

To these speculations it may be answered that it is not at all likely that these flies have the opportunity of becoming infected from passing canoes, which during the last two years have been few and far between, or to natives still frequenting the Lake-shore. Our canoe-men and fly-boys have been kept under careful supervision during the whole of the time, their blood constantly examined, and once a month blood from each of them injected into a healthy monkey. There remain, then, the two theories—long duration

of life of the fly, and a local reservoir. The former cannot at present be answered, and there is no experimental proof of the latter, since the injection of the blood of the Lake-shore birds and mammals into susceptible animals has always, up to the present, given negative results.

Glossina palpalis *as a Carrier of* Trypanosoma vivax *in Uganda.*

By Colonel Sir DAVID BRUCE, C.B., F.R.S., Army Medical Service; Captains A. E. HAMERTON, D.S.O., and H. R. BATEMAN, Royal Army Medical Corps; and Captain F. P. MACKIE, Indian Medical Service. (Sleeping Sickness Commission of the Royal Society, 1908–09.)

(Received November 27,—Read December 9, 1909.)

One of the important trypanosome diseases of cattle in Uganda is that caused by *Trypanosoma vivax* (Ziemann). This species of trypanosome appears to be widely distributed in Central Africa. It has been reported from Senegal, the Sudan and Erythrea in the North, to Rhodesia in the South. It is fairly easily recognised on account of its extreme activity during life, its characteristic shape in stained specimens, and the fact that it only affects cattle, goats, and sheep; while monkeys, dogs, rabbits, guinea-pigs, rats, and mice are refractory. Its carriers have usually been reported as tabanus and stomoxys.

This short note is written to place on record that fact, that in Uganda the tsetse flies, *Glossina palpalis*, which are found in large numbers on the Lake-shore, are infected, not only by *Trypanosoma gambiense*, the cause of sleeping sickness, but also by *Trypanosoma vivax*. The first experiment which showed that these tsetse flies are infected with the latter trypanosome was the following:—

Experiment 1318.—Calf.

To ascertain if oxen will become infected by trypanosomes if allowed to feed in the "fly area."

July 12, 1909. A healthy calf was taken down to the Lake-shore at Kibanga and ferried across the bay to Nsonga, where tsetse flies are numerous. The flies were observed to feed on it in numbers. It was then brought back to Kibanga. In future this calf will be taken out every day by the fly-boys to different parts of the Lake-shore, where it will graze while the boys are catching tsetse flies.